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# THE
# MORRIS ARBORETUM
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Swiss Stone Pine
*Pinus Cembra* L.

The Swiss Stone Pine illustrated in this number is a tree characteristic of the Alpine region of Central Europe, but its range extends to the northeastern part of Russia and Northern Asia.

This handsome, hardy species, reaching a height of from 75 to 120 feet, has a narrowly pyramidal top that may even become strikingly columnar (var. *columnaris* Beissn).

The straight, dark green leaves, borne in fascicles of five, have a serrulate margin. The cones are short-stalked, ovoid, light brown, from 2½ to 3½ inches long, and bear large, edible seeds about ½ inch long.

RODNEY H. TRUE

*Photograph by*
GUSTAVE LIEBSCHER

# FLOWERING CRAB-APPLES*

—BY—

DR. GLEN P. VAN ESELTINE

*New York State Agricultural Experiment Station, Geneva, New York*

LOVERS OF ornamental trees are appreciating more and more the various qualities found in the flowering crab-apples. Hardy in the climate of the northeastern states, with colors ranging from deep or purplish red through pinks to white, and varying in stature from trees 50 feet high to shrubs 8 feet high, displaying gorgeous fall foliage and fruits, they seem to meet all demands.

Crab-apples may be grown from seed, but are usually worthless, and only a few chance crosses have given excellent forms. The creation of definitely planned hybrids is being studied at the Arnold Arboretum and at the New York State Agricultural Experiment Station. This is done when the young bud is almost ready to open. The petals and stamens are cut away, leaving the stigmas. In the more difficult crosses, the anthers are removed from the filament instead. The flowers so treated are covered by paper bags to prevent pollination before the desired pollen is applied either by brush or by finger tip. The flowers are crossed now, bagged again, and kept so until the fruit has set. The bags are then replaced by netting sacks to prevent the fruit from falling to the ground or being eaten by birds. The seeds obtained are placed in a wire screen and buried in the soil over winter. Early in the following spring, the seeds are sown in flats and the seedlings, as they come up, are set in paper pots for transplanting to the nursery. They finally reach the seedling orchard for observation. The large majority of them are thrown out as undesirable. The plants kept are budded onto field-grown seedlings. Propagation by bench grafting is used, but a whip graft is more often used.

In both budding and grafting the stock should be a congenial type. When uncongenial, the scion may outgrow the stock, or the stock may outgrow the scion. Ordinary apple stocks are not suited to all crab-apples, a short-lived tree resulting. On the basis of present knowledge, it seems evident that the prairie crab *(Malus ioensis)*, or the wild sweet crab *(Malus coronaria)*, form the best stocks for American types, and the French crab or Siberian or Tea Crabs for Asiatic types.

The culture of crab-apples is easy. They respond to plenty of sunlight, good drainage, sufficient humus to hold the soil moisture, and to fertilizers high in nitrogen, such as ammonium or nitrate salts. Pruning for shape only is the rule. Young plants of crabs and some others may need to be cut back heavily to force a shrubby growth. Hedges are pruned in June after the flowering period, and again in July. Later pruning would destroy the bloom for the following year.

* Summary of a lecture given at the Morris Arboretum of the University of Pennsylvania on March 13, 1937.

Diseases and pests are not numerous and can be controlled. Apple scab and "cedar" or Juniper rusts are the diseases, and aphids the chief pest.

The cedar rust and the quince rust are sometimes severe in this region. The cedar rust spreads from cedar to apple and back again. It forms spots on the leaves of the apple and may defoliate it. The fruit is also often affected. On the cedar tree the fungus forms "cedar apples" and spore-bearing "horns" project from the apple in all directions. When the horns no longer become turgid when moist, the danger of infection is past. In the "quince rust" the quince is the alternate host. Both release their spores in wet weather. Hence, spraying for this disease is done immediately preceding a rain.

The treatment consists of sprays carrying colloidal sulphur. The Arnold Arboretum recommends the following spray solution for "perfect control" of the Juniper rust:

> **To 5 or 6 pounds of colloidal sulphur made by the Mechling Company, Camden, New Jersey, sold under the trade name of "Linco," 3 pounds of "S.S.3" to 100 gallons of water. S.S.3 is a commercial "spreader" obtainable at any store selling spray materials. Spray first when the young leaves become visible and follow with four or five sprays at 6- to 10-day intervals.**

The pathologists of the New York State Agricultural Experiment Station at Geneva recommend for amateur use as alternatives to "Linco," either "Kolofog" produced by the Niagara Sprayer & Chemical Company, of Middleport, New York, or the Dry Flotation Sulphur, made at the Camden Coke Plant, Camden, New Jersey. Skimmed milk will serve as a spreader when such is needed. The quantity of spreader is determined by experience. The spray must cover every bit of growing tissue, but not run off.

Nicotine sulphate with hydrated lime to release the nicotine is used for control of aphids: 1 pint of sulphate and 3 to 4 pounds of hydrated lime to 100 gallons of water.

Lead acetate, 3 pounds to 100 gallons of water, will control chewing insects.

Concerning ornamental values, crabs may be massed or grown as specimens. As to blooming succession, the Manchurian crab-apple *(Malus baccata mandshurica)* blooms first, and is also the tallest kind, sometimes reaching a height of 50 feet. A week later the Toringo *(Malus Sieboldii)* and Sargent *(Malus Sargentii)* crabs flower. Sargent's crab, the smallest of the Asiatic types, seldom exceeds 8 feet in height, with a spread of 15 or 16 feet. Both the Manchurian and the Sargent crabs are excellent in flower and in fruit.

Scheidecker's crab, a hybrid between *Malus floribunda,* the Japanese flowering crab, and *Malus prunifolia,* the pear-leaf crab, reaches a height of 18 to 25 feet.

The Chinese flowering crab, *Malus spectabilis,* and its variety *Riversii* (sometimes called *rosea* f. *plena)* are ordinarily rather erect types.

Reference was made to the hybridization work being carried on at the New York State Agriculture Experiment Station at Geneva, New York, where some outstanding types have appeared. A cross between *Malus zumi (baccata mandshurica* x *Sieboldii)* and *Malus niedzwetzkyana* (the red-vein crab) is specially promising, and further developments will be watched with much interest.

Some of the American species have interesting form with horizontal branching, as the Missouri crab *(Malus bracteata)* a close ally of the Prairie crab *(Malus ioensis);* Bechtel's crab is a completely double-flowered form of the latter.

The open-headed type of the American crab is illustrated in the Hall crab *(Malus Halliana).* The flowers differ considerably in size and color.

Several sorts were briefly characterized:

The Tea crab, resembling a cherry more than a crab in its fan-like aspect; Parkman's crab, a semi-double variety of *Malus Halliana,* with long, drooping pedicels, and low-growing habit; *Malus floribunda,* the Japanese flowering crab, one of the oldest and most popular types; the Carmine crab *(Malus atrosanguinea)* —*(Malus Sieboldii* x *Malus Halliana)*—retaining the deep color of the young flowers, are prominent types.

The wild American crab *(Malus coronaria)* is a fragrant, thorny, small tree with gorgeous blooms. The American types bloom last of all.

The value of the fruits for ornamental purposes, as well as an attraction for birds, was discussed. The Japanese flowering crab and the cut-leaf crab *(Malus toringoides)* were given special mention. A list of the twelve best crabs follows:

1. *Malus Arnoldiana (floribunda* x *baccata).*
2. *Malus atrosanguinea (Sieboldii* x *Halliana).*
3. *Malus coronaria* and form *Charlottae* (American).
4. *Malus floribunda* (Asiatic).
5. *Malus Halliana Parkmanii* (Asiatic).
6. *Malus ioensis plena* "Bechtel's crab" (American).
7. *Malus hupehensis* and form *rosea* (Asiatic).
8. *Malus purpurea Eleyi (Niedzwetzkyana x atrosanguinea).*
9. *Malus Sargentii* (Asiatic).
10. *Malus Sieboldii* "Toringo" (Asiatic).
11. *Malus spectabilis* and var. *Riversii* and var. *albi-plena* (Asiatic).
12. *Malus toringoides,* "cut-leaf" (Asiatic).

*Summary by* Rodney H. True

# THE ORDER OF BLOOM OF WOODY TREES AND SHRUBS

—BY—

DR. DONALD WYMAN

*Arnold Arboretum, Jamaica Plain, Mass.*

THE SEQUENCE of the order of bloom of trees and shrubs is a very important phenomenon to the practical gardener, for with an accurate knowledge of it he can have woody trees and shrubs in bloom a greater part of the year. One of the most important things in a study of the sequence of bloom is the association of plants which are in bloom at the same time and so can be used together in the landscape scheme. The actual time of bloom is not nearly as important as this association, since in some years the season may be retarded or advanced, depending on the climatic conditions. The association of plants which bloom together will always be the same no matter whether the season is retarded or advanced. The time of bloom of the following notes has been taken in Boston, Massachusetts, and may be at least two weeks earlier for the Philadelphia area.

The first woody plant of the year to bloom is *Hamamelis vernalis* which often opens its flowers on January first even as far north as the Arnold Arboretum. These witch-hazels are a most interesting group, since it is they which "tie in" the full year of bloom, for *H. virginiana* is the last plant in the fall to bloom, and *H. vernalis* is the first plant of the year to bloom. This is immediately followed by *H. japonica* and *H. mollis*, both of which are excellent for their early flower. They come sometime in February or March, depending on the season.

In early April several shrubs are of interest. The alders, with their catkins, are familiar to everyone; *Cornus mas* is usually a brilliant yellow for a week or more; the February daphne with its small but effective purple flowers is also of interest, particularly valued in the landscape because in late summer it will have bright red berries. *Erica carnea*, the spring heath, of which there is a white-flowered form available, also blooms in early April, and if protected will make a good display. *Lonicera fragrantissima* needs no introduction, nor does *Populus tremuloides* nor *Salix discolor*, the common pussy willow. All these plants normally flower in early April.

In mid-April we can expect the small bright red flowers of *Acer rubrum*, the rosy-purple flowers of *Rhododendron mucronulatum*, which although it is a true rho-

* Summary of a lecture given at the Morris Arboretum on April 10, 1937.

dodendron, is commonly thought of as an azalea, and as such is the first azalea of the year to bloom. Although *Benzoin aestivale, Corylopsis* species, and *Forsythia* species also bloom at this time, the azalea is most outstanding, because the color of its flowers differs widely from the yellow flowers of most of these shrubs of this early period. There are a few plants like the bush-honeysuckles, Japanese barberries, and *Prinsepia sinensis,* which by this time are starting to show their leaves and are among the first shrubs to become green in the spring. This is an important feature, for often we may wish to enjoy our gardens at a definite period early in the year, and one or two of these shrubs showing the strong green color will be greatly valued if planted in the right location.

By late April the small greenish yellow flowers of *Acer platanoides* are out; the larches are beginning to show green; *Magnolia kobus* and *M. stellata* are in full bloom; and the delicate nodding clusters of *Pieris floribunda* and *P. japonica* can be seen in many places enhancing a garden nook. At this time, too, the first of the Japanese cherries begin to bloom, particularly the single-flowered types such as *Prunus subhirtella* and its weeping variety, *P. subhirtella pendula,* the Sargent cherry, *P. Sargentii,* and the Yoshino cherry, *P. yedoensis.*

By early May we are definitely assured that spring has come to stay, for there are many plants which are in full bloom by that time. A few of these would be the shadblows; *Rhododendron obtusum* varieties, such as *amoenum* and "*Hinodegiri*"; the brilliant red, pink, and white forms of the Japanese quinces, which were so valued in old-fashioned gardens, but since the advent of Japanese barberries have not been used in hedges any more because they are susceptible to fire blight, borers, and scale. Many of the blooms *(Cytisus* and *Genista)* are becoming conspicuous at this time for their yellow flowers. It is interesting to know that there are white-flowered forms available and even a purple-flowered form. Other magnolias in full bloom would be *Magnolia denudata* and the many varieties of the saucer magnolia, *M. Soulangeana.* The yellow flowered *Mahonia Aquifolium* is at its height at this period and certain other cherries, particularly some of the double-flowered forms. The old-fashioned *Ribes odoratum* is a mass of golden-yellow, and its very fragrant flowers are admired by everyone, particularly when it is planted in combination with such white-flowering plants as the *Spiraea prunifolia plena* and *S. Thunbergi,* which are also in bloom in early May.

Just a very few of the plants in bloom in mid-May would be *Alyssum gemonense* and *A. saxatile, Caragana arborescens,* with its yellow pea-like flowers, the redbud, and the native flowering dogwood, which together make an excellent

flowering combination. The outstanding display of this period might be the azaleas, particularly *Rhododendron Schlippenbachii, R. Vaseyi, R. yedoense poukhanense,* and *R. obtusum Kaempferi,* the last being the most brilliant flowering shrub which the Arnold Arboretum has had the opportunity of introducing from Japan.

The peculiar *Fothergilla* with its thimble-like flowers is conspicuous at this period, as is also the dainty silverbell, and the last of the saucer magnolias to bloom, the variety *M. Soulangeana Lennei.* The crab-apples almost always give a splendid display of bloom, and it is impossible in this short space to mention them all. However, some of the single-flowered forms such as *Malus arnoldiana, M. atrosanguinea, M. baccata, M. floribunda, M. micromalus, M. purpurea,* and *M. Sargenti* are all at their best together with double-flowering forms such as *M. Halliana Parkmanii, M. Scheideckeri,* and others. Also some of the larger of the double-flowering Japanese cherries would be still in bloom by mid-May such as "Fugenzo," "Shirotae," and "Kwanzen," all of which are good and very popular. Although normally the lilacs do not bloom until late May, nevertheless the first of the lilacs bloom in mid-May, and these would be varieties of *Syringa hyacinthiflora* and *S. oblata.* The very fragrant *Viburnum Carlesii* is also at its best in mid-May. The first of the *Weigelas* (Fleur de Mai) also begin to bloom at approximately this time.

By late May the horse chestnuts, the hybrid azaleas, and the many species and varieties of lilacs are all at their best. The hawthorns are beginning to bloom, many of the *Deutzias* are in full flower, and often a *Laburnum* can be seen somewhere to thrill many with its long golden clusters of bright yellow flowers. The bush-honeysuckles are in full bloom, the native crab-apples such as *Malus coronaria,* and *M. ionensis plena* are at their best. Usually a *Rhododendron* such as the hybrid "*Boule de Neige*" is in flower at this period, for this is one of the first hybrids to appear in the spring. Certain roses, such as *Rosa hugonis* and *R. primula,* open their yellow flowers at the same time as these shrubs of late May. *Viburnum tomentosum plicatum* and the wisterias should not be forgotten, since they too supply most interesting flowers during late May.

In early June the hawthorns begin to flower, the fringe-tree is outstanding. *Rhododendron calendulaceum* with its brilliant orange flowers is of interest for at least two full weeks. The many hybrid rhododendrons are also in bloom during early June, and there are at least fifteen varieties of these which are perfectly hardy as far north as the Arnold Arboretum. Since June is the month of roses, we know that certain shrubs like *Rosa blanda, R. virginiana,* and *R. multiflora* are expected

to bloom in early June, and the sequence of roses will be carried on later with the many hybrid "teas" and "perpetuals."

By mid-June some of the clematis start to bloom, and the mountain laurel can be expected to give joy everywhere it is seen.

In late June the sweet-scented *Rhododendron arborescens* is in flower, together with such outstanding plants as *Tripterygium Regelii* and *Rhododendron maximum*. It is interesting to note that many of the bush-honeysuckles will have fruit on at this period that is just beginning to color, and so they too have their value in this landscape scheme.

During July many of the clematis clan will flower, the lindens will interest many with their sweet-scented blossoms. *Campsis radicans* will be outstanding everywhere with its large, scarlet trumpet-like flowers. The heathers too will be in full bloom, as will *Koelreuteria paniculata, Lonicera sempervirens, Rosa setigera,* the *Buddleias,* and the sweet-scented summersweet, *Clethra alnifolia.*

By August comparatively few shrubs will flower, but there will always be that strange *Albizzia julibrissin rosea* with its silk-like flower clusters, the large flowering *Hydrangea "Pee Gee,"* the *Vitex.* It should always be kept in mind that many of the shrubs will have fruits which are beginning to change color at this time and so can be used for this purpose.

In September *Clematis paniculata* and *Polygonum Aubertii* can usually be depended upon for excellent flower displays, and the *Gordonia altamaha* does not even begin to bloom until about the middle part of September and will continue, at least in the Arnold Arboretum, until frost eventually kills the flowers.

The last plant of all the year to bloom is the native *Hamamelis virginiana.*

## THE JAPANESE BEETLE

*—BY—*

PHILIP P. CALVERT

*Professor of Zoology, University of Pennsylvania.*

THE JAPANESE BEETLE, *Popillia japonica,* is one-half inch long, shining green at head and tail, brown with shining green reflections on the middle portion (wing-

covers or elytra) of its body above, while it is of a duller, darker, but still shining green below. On the body's surface, especially underneath, are many white hairs, often in rows or tufts, and so arranged as to give the appearance of five white spots on each side just below each brown elytron, and a pair on the upper surface near the hind end. These white markings are characteristic. While males are often smaller than the females, one can not always rely on size to distinguish them. To be sure of the sex, one must look at the first pair of legs with a low power lens; if the two claws at the tip of each leg are of nearly equal thickness the individual is a female, if one claw is markedly thicker than the other, we have a male. In addition, the last long joint (tibia) of each male first leg has a pointed projection at its tip, while in the female the corresponding part is rounded.

These beetles are to be seen around Philadelphia from mid-June to October, although they are most numerous in late July and early August. On warm bright days they fly actively and feed voraciously, not less than 260 kinds of plants having been observed to serve as food at one time or another.

Beginning in July the females burrow in the ground to a depth of 2 to 4 inches, where they lay a few elliptical, later spherical, eggs, one-sixteenth of an inch in diameter. Ascending to the air, they resume feeding and later burrow again to deposit additional eggs. This alternate eating and ovipositing may extend over many days until the 40 to 60 eggs, to be found in the ovaries of a single female, have been placed in the soil. Each egg requires about two weeks to hatch, when it yields a white grub or larva, having a cylindrical body curved or bent upon itself, when not crawling. The grub feeds upon the roots of plants, and increases in length from one-eighth of an inch to one-inch in length during a period of approximately ten months. This grub, or larval, existence is divided by two moults, or sheddings of the outer covering of the body, into three periods (instars), the first of which usually occupies about three weeks, the second about three weeks and the third eight-and-one-half months. This third larval period or instar is consequently the one in which the winter is passed, and during it the grub is often inactive and may not eat until spring is well established. However, even under natural conditions, the first or the second instar may be so prolonged that cold weather overtakes the grub in that period, with the result that the other one or two instars may not follow until spring. Experimentally also, as has been shown by Dr. Daniel Ludwig, it is possible to modify the lengths of these instars by different kinds of food and by temperature, so that, as he says, "the life history at 20 degrees centigrade is different from that at 25."

In May or in June larval life normally comes to an end when another moult marks the change to the pupa, a non-feeding, quiescent condition, in which the wings, legs and feelers of the future adult first appear on the exterior of the body. Finally, after 8 to 20 days, the last moult, casting away the pupal "skin," produces the adult beetle which shortly ascends to the surface of the ground. Thus a "complete transformation" or "complete metamorphosis" is accomplished, whose distinguishing feature is the non-feeding, non-growing, non-reproducing pupal stage, inserted between the feeding, growing but non-reproducing grub and the feeding, non-growing but reproducing adult beetle. Butterflies, moths, wasps, bees, ants, flies are other insects which undergo a "complete" transformation. In them, as in the beetles, we see another characteristic of "complete" metamorphosis: the body of the adult is shorter than that of its own preceding full-grown caterpillar, grub or maggot. On the other hand, such insects as grasshoppers, crickets, dragonflies and bugs, which have no pupal stage and therefore show an "incomplete" transformation, progressively increase in body length throughout their individual lives. The shrinkage in length which characterizes the adult insects with complete metamorphosis is doubtless correlated with the more thoroughgoing changes in their internal organs which take place during late larval and pupal periods, as contrasted with the slighter alterations in the viscera experienced by the other group.

The contrast between the larva of the Japanese beetle and the beetle into which it develops is very striking: the former in the soil, in darkness, crawling slowly from root to root, the latter in the air, in light, flying vigorously from leaf to leaf, to flower, to fruit. Not all beetles show such a divergence in their successive abodes. The (Colorado) potato beetle, so often miscalled potato *bug*, lives both as larva and as adult on the foliage of the potato family; the change in habits and surroundings is not as great here as in the Japanese beetle, but both have a pupal stage spent in the ground and it is as an adult, in the ground, that the potato beetle passes the winter. The potato beetle achieves two generations a year, while the Japanese beetle has but one in that time.

The preeminence of the Japanese beetle as a destructive insect is due to its wide rang of food plants in the adult stage, already mentioned. Protect the plants of the potato family and a few others in a given area, and the potato beetles and their grubs die of starvation because they are unable to eat other kinds of food. Protect plants from Japanese beetles and these insects readily adjust themselves to members of widely different families of plants. Within the vegetable kingdom, the Japanese beetle is largely omnivorous and as such possesses all the advantages of the unspecialized in the struggle for existence.

As its common name indicates, the Japanese beetle is a native of the Land of the Rising Sun and is believed to have been first found in the United States in 1916, near Riverton, New Jersey. It presumably came in the grub stage in soil accompanying imported plants. Its spread between 1916 and 1923 was steady but in the latter year, says Dr. Henry Fox, "there ensued a remarkable acceleration of the rate of spread which can only be explained by assuming that some factor of dispersal, not previously operative, had come into play. This factor I find in the fact that in 1922 for the first time the beetles invaded the great freight and shipping centers in the cities of Camden and Philadelphia. As a result of their becoming accidentally imprisoned in freight cars, shipholds and other closed conveyances, beetles would be carried away from these centers with no chance to escape until their conveyance reached its destination. . . . Moreover there has come about, within the past few years [this was written in 1927], in the heavily infested area, an increased use of motor vehicles to transport farm produce to distant points accessible to this form of traffic. There is, accordingly, good ground for assuming that the sudden leap in the beetle's range which characterized the season of 1923 and which has been a marked feature of its subsequent spread, is not to be attributed to any sudden increase in the innate dispersive capacity of the insect itself, but to the fact that, as a result of these two conditions, neither operative on an extensive scale previous to 1922, its artificial dissemination through these means became factors of major importance in extending the insect's apparent range."

The natural spread of the beetle by its own efforts was estimated by Dr. Fox, in 1932, to have occurred at a rate of 6 miles per year to the east of Riverton, the Atlantic Ocean having been reached in 1926, southward at 4.5 miles per year with the attainment in New Jersey of Delaware Bay in 1930, northward and westward at 3 to 4 miles per year. He adds: "It is of interest to contrast the distances to which, from 1918 to 1931, the Japanese beetle has been carried through its own efforts with those to which it has been conveyed through artificial agencies. The former range from 35 to 60 miles, whereas the distances in miles from the original center of the distribution area to certain of the more distant points at which Japanese beetle colonies are recorded are approximately as follows: Boston, Massachusetts, 270; Buffalo, New York, 290; Columbus, Ohio, 430; Richmond, Virginia, 250; Norfolk, Virginia, 250; Charleston, South Carolina, 575." Still more recently, the beetle has been noted at St. Louis, Missouri, 850 miles from Riverton. Looking into the future and comparing the climatic conditions in Japan with those in the United States, Messrs. Hadley and Hawley, in their general survey of 1934, think that

"the Japanese beetle will be able to develop in most of the states east of western Kansas. In northern New England and in the interior north of Illinois, Missouri and Nebraska, the winter temperatures may be low enough to prove fatal to larvae especially in the absence of snow."

This naturally brings us to consider the question frequently asked as to the effect of recent cold winters, 1933-35, in the Philadelphia area on the grubs of this beetle. This has also been dealt with by Dr. Fox in a special paper. It appears that about 15 degrees Fahrenheit is the lowest temperature which the grubs can withstand under natural conditions. Such degrees of cold have been recorded in the soil at Minneapolis to a depth of about 12 inches, well below that at which Japanese beetle grubs usually occur. Such low temperatures only exist when there is no snow lying on the ground. At temperatures lower than 50° F. the grubs are inactive and in most years, in the vicinity of Philadelphia, they rarely are more than five inches below the surface when this soil temperature is reached. In the cold spell of February, 1934, the presence of snow prevented a drop of soil temperature to anything near 15° F. and the existing evidence is that the grubs did not burrow more deeply in that winter than in other warmer years. The conclusion is, therefore, drawn that only when a cold period is sufficiently long, and is unaccompanied by a snow cover, does the soil become cold enough to cause the death of the grubs. Deeper burrowing by the latter does not occur.

It has already been mentioned that the adult Japanese beetle has been observed to feed upon approximately 260 different kinds of plants, "but it does not relish all of these to the same extent." Other plants are rarely or never attacked by this beetle. In the endeavor to determine what causes the preference on the part of the insect, an investigation of the relation of sugar content and odor of clarified extracts of plants to their susceptibility to attack was made by Messrs. Metzger, van der Meulen and Mell. A study of ninety-seven plants led them to the conclusion that those having 15 or more milligrams of reducing sugar (dextrose) per gram of their own weight and a fruity odor to their clarified extracts are favored by the Japanese beetle, while those with a smaller proportion of dextrose and lacking a fruit-like odor to their extracts are not attacked, or but lightly attacked. The nature of the substances causing the fruity odor was not determined. These results, however, do not apply to certain plants which grow in the shade, or whose leaves are hard, waxy, or hairy, so that the beetles cannot feed upon them readily.

From these and other observations it is inadvisable to plant ornamental trees and

shrubs such as linden, horse-chestnut, some maples, elms and sweet cherries, which are known to be especially favored by the Japanese beetle. If already planted, they can be protected by spraying, but why plant them new when they need so much protection, unless cost in labor and materials be no deterrent?

From the wide range of food and the long active season of the Japanese beetle, it follows that foliage, flowers and fruit may be attacked in succession. Leaves and blossoms may in many cases be protected from insect attack, but it is often impossible to apply any remedy to fruit on the tree that will not interfere with its use as human food. Lime has been the favorite repellent where arsenates are out of the question, while very recently (1937) Guy and Schmidt say that derris or tetramethyl thiuram disulphide, combined with a rosin sticker, offers considerable promise. Harvested fruit, in course of transportation, has been fumigated with little or no disagreeable effects.

The subterranean grubs have also been attacked by chemical means. Arsenicals, naphthalene and paradichlorobenzene applied to soil have caused death of larvae and have been found by Lipp to prevent egg-laying for as many as 32 days under experimental conditions. The effectiveness of all chemical treatment for both adults and grubs varies with environmental conditions and the subject is too extensive to be dealt with here.

The usefulness of traps in reducing the numbers of Japanese beetles has been called in question. Metzger, writing last year, says: "No definite statement can be made regarding the effectiveness of traps in areas of heavy or even moderate infestation. After ten years' experience, these devices are more efficient in lightly infested districts. Improvements in bait have not resulted in a trap which will attract all the beetles in the immediate vicinity, nor have the improvements in the trap resulted in one which will capture all the beetles which are attracted." His latest recommendation as to the bait is that it be composed of geraniol, 20 parts, eugenol, 2 parts, and phenyl ethyl alcohol, 1 part.

The biological checks to the increase of insects are chiefly insectivorous vertebrates and insects. Certain birds and mammals have been observed to feed upon the adults and grubs of the Japanese beetle. Adults have been found in the stomachs of purple grackles and they are eaten also by the starling, cardinal, meadow lark, cat bird, English sparrow, robin, chicken, turkey and ducks, while the starling, purple grackle, crow and chicken consume the grubs. Sim conducted feeding experi-

ments on caged mammals, offering them Japanese beetle grubs with other food. He reports: "The majority of our small terrestrial mammals are more or less enthusiastic feeders upon Japanese beetle grubs, the common mole, the large short-tailed shrew, the skunk and perhaps the pine mouse are in this way the most important. Each shrew will eat from 10-20 larvae before getting enough for one meal. In an hour or less it is dinner time again."

Soon after the seriousness of the Japanese beetle plague in New Jersey was realized, entomologists of the United States Department of Agriculture began investigations, through nine years, 1920-1928, of this insect and of other species of the genus *Popillia* in the Far East. During the first four years' study in Japan, the Americans did not observe it as a serious pest, although Japanese writers have recorded it as at times doing considerable damage to soybeans. Assuming that its relative unimportance to plant cultivation in that country was largely due to insect enemies which held it in check, special attention was directed to the native parasites. As a result five species of flies were found attacking the adult *japonica* and one fly and one wasp infesting the grubs. Other flies and wasps normally attacking other species of *Popillia* will turn their attention to *japonica* on opportunity. The first five flies mentioned lay their eggs upon the adult beetle which is devoured by the maggot which penetrates it or they give birth to active maggots which, in ways still unobserved, succeed in entering and destroying the beetle. The fly responsible for parasitizing the Japanese beetle grub, as well as one from Chosen (Korea) which will attack it, lay living maggots on the soil and these seek the grubs, guided perhaps by the sense of smell, and on finding the objects of their search penetrate and feed within them. The adult female wasp burrows in the soil until she finds a beetle grub, stings it, producing paralysis of the latter, and then attaches her egg to the surface. The wasp larva after hatching remains upon the exterior of the grub feeding through a puncture made by its jaws in the grub's skin.

Up to 1928, parasitized beetles and grubs with their fly parasites, wasps and wasp cocoons, to the number of above one million-and-one-third insects, were shipped from the Far East to the Riverton laboratory. In 1934 Hadley and Hawley stated that five species of parasites, three from Japan and two from Chosen, were established in the infested area of the United States. Two of them, both wasps *(Tiphia)*, are more promising than the others. Of one of these *(Tiphia popilliavora)*, from Japan, Brunson says that 191 colonies, each of 100 females, were liberated between 1927 and 1931. Shipments of the other wasp *(T. vernalis)*, from Chosen, were con-

tinued yearly to 1933, when it was considered that "further importations are no longer necessary as several locally established colonies are now sufficiently large to supply material for colonization purposes" (Gardner). Balock states that diggings in 1933 at Overbrook, Pennsylvania, colonized by *vernalis* in 1929, indicated a parasitization of 7.4 per cent of 214 beetle grubs examined, and similar diggings at Philmont, Pennsylvania, in October, 1933, showed parasitization of 28.8 per cent over a limited area.

Still another biological method of combatting the grubs is to infect the soil with thread worms (nematodes), which, taken in with food by the grubs, destroy the latter. Methods for cultivating the thread worms for this purpose and for inoculating soil with them are being developed by Glaser and associates.

The literature on the Japanese beetle is becoming extensive and only brief indications of some recent sources of information can be given here. General information, by Hadley and Hawley, is in Circular 332 (1934) of the U. S. Department of Agriculture and by Rex in Circular 242 (1934) of the New Jersey Department of Agriculture. Ludwig's paper is in Physiological Zoology, volume V (1932), that by Metzger, van der Meulen and Mell in the Journal of Agricultural Research, volume 49 (1934). Accounts of the parasite investigations in the Far East by Clausen and associates are in Bulletin 1429 (1927) and Technical Bulletin 366 (1933) of the U. S. Department of Agriculture. Glaser's papers may be learned in Circular 265 (1936) of the N. J. Dept. of Agric. The papers by Fox, Guy and Schmidt, Lipp, Metzger, Sim, Brunson, Gardner and Balock will be found in the Journal of Economic Entomology, volumes 20 (1927), 25 (1932), 27-30 (1934-37). Almost all of these articles contain lists of earlier literature.

## NEW MEMBERS OF THE ADVISORY BOARD OF MANAGERS

THE VACANCIES in the membership of the Advisory Board of Managers, caused by the passing of Mr. Harper and of Colonel Robert Glendinning, have been filled by the acceptance of membership by Messrs. Thomas D. M. Cardeza, Horace H. F. Jayne and Wharton Sinkler, all of Philadelphia.

# MORRIS ARBORETUM FELLOWS

AMONG THE PURPOSES to be promoted by the Arboretum is the maintenance of post graduate work for students after they have finished their preliminary groundwork in school or college. This provision was carried out in August, 1933, by the appointment of five Fellows, each enjoying a stipend of $1200 per annum. These Fellows enrolled in the Graduate School of the University, and pursued work looking to the taking of higher degrees in botanical science.

Since in training and in sending these young men and young women to their several subsequent positions, the University and the Aboretum have rendered a genuine service in advancing plant science and its useful applications, it has seemed worth while to give a brief statement of their activities.

LEWIS E. ANDERSON

Born in Batesville, Mississippi, he was appointed to a Morris Arboretum Fellowship in August, 1933, being reappointed for the following school year of 1934-35. He took his Ph.D. degree in June, 1936, the subject of his dissertation being "Mitochondria in the Life Cycle of Certain Higher Plants." He assisted in the teaching work at the University. During the following school year, now closing, Anderson has been a member of the botanical staff of Duke University, with which institution he will continue during the coming year.

RUTH L. BEALL

Born at West River, Maryland, and a graduate of Goucher College, Miss Beall was appointed to a Morris Arboretum Fellowship in August, 1933, a position she continued to hold until February, 1936, when she took her Ph.D. at the University of Pennsylvania. She was appointed to the botanical staff of the University of Georgia, a position she still holds. She teaches classes in plant physiology. Her dissertation dealt with the "Absorption of Electrolytes by Seedlings."

THOMAS W. CHILDS

Born at Rockwell City, Iowa, Mr. Childs was also appointed in August, 1933, held his Fellowship until June, 1936, when he took his Ph.D. degree at the University of Pennsylvania. His major subject was in Forest Pathology, his dissertation dealing with the "Variability of Polyporus Schweinitzii in Culture." He was im-

mediately appointed to the U. S. Bureau of Plant Industry of the Division of Forest Pathology, at Portland, Oregon, a position he still holds.

ESTHER L. LARSEN

Miss Larsen, born at Minot City, North Dakota, was appointed in 1933, and reappointed for the year 1934-35. She has taken her preliminary examination for the Ph.D. degree at the University of Pennsylvania. Her special subject of study is "A Study of the Tidal Marsh and Beach Flora for East Central Delaware." She has married Dr. K. D. Doak, of the Division of Forest Pathology, in the U. S. Department of Agriculture, now stationed with the Allegheny Forest Experiment Station, co-operating with the University of Pennsylvania.

WILLIAM E. MCQUILKIN

Mr. McQuilkin was born at David City, Nebraska and accepted a Morris Arboretum Fellowship in the fall of 1933. After a year he became a teaching assistant in the Botany Department at the University, a position held until he received his Ph.D. degree in June, 1936. His dissertation dealt with the "Root Development of Pitch Pine With Comparative Observations on the Short Leaf Pine." He accepted an immediate appointment with the Conservation work of the national Department of Agriculture, with headquarters at Lincoln, Nebraska. He is still in the Government service, with the Appalachian Forest Experiment Station, at Asheville, North Carolina.

The record made by the Arboretum Fellows is most creditable. They have accepted significant places in the educational world or in the research personnel of Governmental agencies, where their several abilities and lines of training will continue to reflect credit on the Arboretum and on the University of Pennsylvania in the years to come.

The appointment of a Fellow for the coming school year, 1937-38, has been authorized, and Mr. F. R. Fosberg, of the Botany Department of the University of Hawaii, Honolulu, has been appointed. His botanical studies began at Pomona College, Claremont, California, under Dr. Philip A. Munz. He later worked in the herbarium of the Los Angeles Museum. In 1932, he was chosen assistant to Professor Harold St. John, of the Botany Department, University of Hawaii, at Honolulu, a position he still holds. In 1934, he was made Botanical Assistant to the Bishop Museum Expedition to the South Seas.

## ARBORETUM VISITORS

THE ARBORETUM has continued to be a favorite place for visitors from Pennsylvania and neighboring states. Classes from schools and colleges come in groups. Garden clubs and various societies meet here.

The women of the University again held their May Day "Frolic" on May 8th, and again the crowning of the Queen followed a dramatic presentation of beauty and novelty. The Alumnae of the University had their annual meeting and luncheon at the Arboretum on the same day. Again, the Senior Garden Party and Class Day Exercises were held at the Arboretum on June 7th.

On Alumni Day at the University, the Arboretum was open all day, in the hope that graduates and members of the University of former years might become more fully acquainted with an institution that has growing significance to the University and to plant science.

## RECENT GIFTS

**Masonic Home,**
Elizabethtown, Pa.
11 plants of trees and shrubs, 9 species.

**U. S. Department of Agriculture,**
52 plants of trees and shrubs, 26 species.

**Dr. Frank M. Jones,**
Wilmington, Delaware.
Cuttings of (immune) Boxwood.

**Mr. Albert Nalle,**
Whitemarsh, Pa.
Seeds of Pseudolarix amabile.

**Mr. John C. Wister,**
Germantown, Philadelphia, Pa.
Scions of 63 species and varieties of Lilac.

**Swarthmore Arboretum,**
Swarthmore, Pa.

Scions of 24 varieties of Malus,
Scions of 23 varieties of Prunus,
Suckers of 20 varieties of Lilac,
28 species of trees and shrubs, 42 plants, and many seedlings.

**Towson Nurseries,**
Towson, Maryland.

Cuttings of 30 varieties of Rhododendrons,
from which 232 plants have been raised.

**New York Botanic Garden,**
New York, N. Y.

11 plants of 6 species of shrubs.

**Department of Forests and Waters,**
Mont Alto, Penna.

17 species of trees, 38 plants.

**Mr. Maurice Bower Saul,**
Moylan, Penna.

10 specimen plants of Pinus, representing 5 species.

**Mr. Charles Fearon,**
Germantown, Philadelphia, Pa.

9 plants, trees.

The Arboretum has been greatly favored by Mrs. Eleanor Widener Dixon, of Elkins Park, who has presented to it a splendid collection of orchids.

In this collection of 233 plants, 37 genera are represented and 91 species. The list includes the following genera in rich variety:

| | |
|---|---|
| **Bulbophyllum** | 6 species |
| **Caelogyne** | 7 species |
| **Dendrobium** | 12 species |
| **Epidendrum** | 7 species |
| **Laelia** | 9 species |
| **Miltonia** | 5 species |

This has an unusual botanical interest to students of orchids, in addition to their appeal to the sense of beauty through unusual forms and color combinations. These plants have been transferred to the tropical house at the Arboretum.

## INDEX TO VOLUME I—MORRIS ARBORETUM BULLETIN

Nos. 1 to 8, Inclusive


| | Page |
|---|---|
| *Abelia grandiflora* hybrid | 50 |
| *Abies balsamea*, Mill. | 75 |
| *Abies cephalonica*, Loud. | 74 |
| *Abies concolor*, Lindl. & Gord. | 74 |
| *Abies Fraseri*, Poir. | 75 |
| *Abies homolepis*, Sieb. & Zucc. | 75 |
| *Abies lasiocarpa*, Nutt. | 75 |
| *Accipiter cooperi* (Cooper's Hawk) | 16 |
| *Accipiter velox velox* (Sharp-shinned Hawk) | 33 |
| *Acer platanoides* | 107 |
| *Acer rubrum* | 106 |
| Acknowledgments | 39–56 |
| *Acitis macularia* (Spotted Sandpiper) | 64 |
| *Agelaius phoeniceus phoeniceus* (Eastern Red-wing) | 66 |
| *Albizzia julibrissin*, Durazz. | 50 |
| *Albizzia julibrissin rosea* | 109 |
| Algae | 38 |
| Allegheny Forest Service | 39 |
| *Alyssum gemonense* | 107 |
| *Alyssum saxatile* | 107 |
| *Amanita muscaria* | 48 |
| Ambler Nurseries | 40 |
| Ambler School of Horticulture | 39 |
| *Anasplatyrhynchos platyrhynchos* (Common Mallard Duck) | 16 |
| Anderson, Lewis E. | 117 |
| Arboretum, at the Flower Show | 38 |
| Arboretum, Beginnings at the Morris Arboretum. | 3–6 |
| Arboretum, Morris | 3 |
| Arboretum, Visitors | 119 |
| *Archilochus colubris* (Ruby-throated Hummingbird) | 64 |
| *Ardea herodias herodias* (Great Blue Heron) | 33 |
| Arnold Arboretum | 24, 39 |
| Associates | 6 |
| Auten, Edward, Jr. | 39 |
| *Baelophus bicolor* (Tufted Titmouse) | 17 |
| Barberries | 87, 89 |
| Barberries, at the Arboretum | 93–96 |
| Beall, Ruth L. | 117 |
| Beauty Bush | 6 |
| Beetle, Japanese | 109–116 |
| *Benzoin aestivale* | 107 |
| *Berberis aetnensis*, Presl. | 95 |
| *Berberis aggregata* | 94, 95 |
| *Berberis aggregata* var. *Prattii*. Schneid. | 50, 96 |
| *Berberis aggregata*, Schneid. | 50 |
| *Berberis amurensis japonica* | 93, 95 |
| *Berberis angulosa*, Wall. | 95 |
| *Berberis Beaniana*, Schneid. | 95 |
| *Berberis Boschanii* | 95 |
| *Berberis canadensis*, Mill. | 88, 95 |
| *Berberis canadensis*, Schneid. | 88, 95 |
| *Berberis chinensis*, Poir. | 95 |
| *Berberis chitria*, Lind. | 95 |
| *Berberis circumserrata* | 89, 94, 95 |
| *Berberis concinna*, Hook. | 95 |
| *Berberis crataegina*, D. C. | 96 |
| *Berberis cretica*, L. | 96 |
| *Berberis, dasystachya* | 94, 96 |
| *Berberis declinata*, Schrad. (*vulgaris x canadensis*) | 96 |
| *Berberis diaphana* | 94, 96 |
| *Berberis dictyoneura*, Schneid. | 96 |
| *Berberis dictyophylla albicoulis* | 94, 96 |
| *Berberis Dielsiana* | 94, 96 |
| *Berberis Edgeworthiana*, Schneid. | 96 |
| *Berberis Faxoniana*, Schneid. | 96 |
| *Berberis fenderli*, Gray | 88 |
| *Berberis Francisci-Ferdinandi*, Schneid. | 96 |
| *Berberis Gagnepainii*, Schneid. | 50 |
| *Berberis Gilgiana* | 89 |
| *Berberis Giraldii* Hesse. | 96 |
| *Berberis heteropoda* | 89 |
| *Berberis Hookeri*, Lem. | 95 |
| *Berberis ilicifolia* | 93, 95 |
| *Berberis insignis*, Hook | 95 |
| *Berberis Julianae* | 93, 95 |
| *Berberis koreana*, Palibin | 95 |
| *Berberis laxiflora*, Schrad. (*vulgaris x chinensis?*) | 96 |
| *Berberis Lecomtei*, Schneid. | 96 |
| *Berberis Leichtlinii*, Schneid. | 96 |
| *Berberis macracantha*, Schrad. (*vulgaris x aristata*) | 96 |
| *Berberis Mouillacana*, Schneid. | 96 |
| *Berberis nummularia* (Bge.) *pyrocarpa*, Schneid. | 96 |
| *Berberis ottawensis* | 93 |
| *Berberis ottawensis*, Schneid. (*vulgaris x Thunbergii*) | 96 |
| *Berberis parvifolia*, Sprague | 96 |

Page

*Berberis Poirettii* ..... 94
*Berberis polyantha*, Hemsl. ..... 96
*Berberis provincialis* ..... 94
*Berberis provincialis*, Schrad. (*vulgaris x sibirica?*)
*Berberis rehderiana* ..... 88
*Berberis Sargentiana*, Schneid. .....51, 95
*Berberis sibirica* ..... 94
*Berberis Sieboldii* .....93, 96
*Berberis Silva-Taroucana*, Schneid. ..... 96
*Berberis Soulieana*, Schneid. ..... 95
*Berberis Spaethii*, Schneid. (*chitria? x x?*)..... 96
*Berberis thibetica*, Schneid. ..... 96
*Berberis Thunbergii* .....93, 96
*Berberis Thunbergii*, var. *argento-marginata*..... 88
*Berberis Thunbergii*, var. *maximowiczii* .....88, 96
*Berberis Thunbergii*, var. *minor* .....88, 95, 96
*Berberis Thunbergii, plurifolio* (*B. ottawensis*)... 89
*Berberis Thunbergii, plurifolia erecta* ..... 88
*Berberis Thunbergii, purpurea* ..... 89
*Berberis Thunbergii, x julianae* (*B. mentorensis*).. 89
*Berberis Thunbergii, x vulgaris* (*B. ottawensis*)... 89
*Berberis Tischleri*, Schneid. ..... 96
*Berberis triacanthrophora*, Fedde. .....50, 95
*Berberis turcomanica*, var. *integerrima* ..... 89
*Berberis Veirchii*, Schneid. .....51, 95
*Berberis Vernae* .....94, 96
*Berberis Vernae*, hybrid ..... 50
*Berberis verruculosa*, Hemsl. & Wils. ..... 95
*Berberis virescens*, Hook. ..... 96
*Berberis vulgaris*, L. .....87, 93, 96
*Berberis vulgaris*, var. *alba* (var. *leucocarpa* K. Koch) ..... 88
*Berberis vulgaris*, var. *albo-variegata* ..... 88
*Berberis vulgaris, argento-marginata* ..... 88
*Berberis vulgaris*, var. *atropurpurea* ..... 88
*Berberis vulgaris*, var. *aureo-marginata* ..... 88
*Berberis vulragis*, var. *dulcis* ..... 88
*Berberis vulgaris*, var. *enuclea* (var. *aspenna* Willd.-var. *apyrena*, Schnad.) ..... 88
*Berberis vulgaris*, var. *lutea* ..... 88
*Berberis Wilsonae* ..... 94
*Berberis Wilsonae*, Hemsl. & Wils. .....50, 96
*Berberis Wilsonae, Stapfiana*, Schneid. ..... 96
*Berberis Wilsonae, subcauliata*, Schneid. ..... 96
*Berberis xanthoxylon*, Hassk. ..... 96
*Berberis yunnanensis*, Franch. ..... 96
Birds at the Arboretum in Late Fall.....15–18

Page

Birds of the Arboretum .....63–66
Birds of the Arboretum, Late Winter.....32, 33
Bittern, American, (*Botaurus lentiginosus*)..... 63
Blackbird, Eastern Red-wing, (*Agelaius phoeniceus phoeniceus*) ..... 66
Bloomfield ..... 3
Blue Jay, Northern (*Cyanocitta cristata cristata*) 17
Bobolink (*Dolichonyx oryzivorus*) ..... 66
*Boletus bicolor* ..... 48
*Boletus brevipes* ..... 47
*Boletus granulatus* ..... 47
*Boletus pictis* ..... 47
*Bombycilla cedrorum* (Cedar Waxwing) ..... 17
*Botaurus lentiginosus* (American Bittern) ..... 63
Boxwood species .....6, 11–14, 27–30
Bromeliads ..... 38
Buddleias ..... 109
Burk, Louis ..... 7
*Bulbophyllum* ..... 120
*Caelogyne* ..... 120
Calvert, Dr. Philip P. .....43–45, 109–116
Calvert, Mrs. P. P. ..... 39
*Calycanthus occidentalis*, Hook & Arn. ..... 51
*Campsis radicans* ..... 109
*Caragana arborescens* ..... 107
Cardinal, Eastern (*Richmondena cardinalis cardinalis*) ..... 18
*Carpodacus purpureus purpureus* (Eastern Purple Finch) ..... 33
Catbird (*Dumetella carolinensis*) ..... 64
Cedar, Gold Tip Red ..... 42
Cedar, White ..... 6
Cedars, Atlas ..... 27
*Cedrela sinensis*, Juss. ..... 51
*Cedrus deodora* ..... 39
*Cedrus deodora*, Laws ..... 28
*Cedrus libanotica*, Link. ..... 28
*Cephalotaxus drupacea*, Sieb. & Zucc. .....29, 76
*Cephalotaxus Fortunei*, Hook ..... 29
*Ceratostomella* .....21, 22
*Certhia familiaris americana* (Creeper, Brown).... 17
*Chaetura pelagica* (Chimney Swift) ..... 64
*Chamaecyparis* (Cypress) ..... 10
*Chamaecyparis filifera*, Bliss. ..... 76
*Chamaecyparis Lawsoniana allumii*, Beiss. ..... 76
*Chamaecyparis nootkatensis* ..... 6
*Chamaecyparis obtusa Crippsii*, Redh. ..... 75

| | Page |
|---|---|
| *Chamaecyparis pisifera*, Endl. | 76 |
| *Chamaecyparis pisifera plumosamea*, Beiss. | 75 |
| *Chamaecyparis pisifera squarrosa*, Beiss. & Höchst. | 76 |
| *Chamaecyparis pisifera sulphurea*, Schelle. | 76 |
| Chickadee, Black-capped (*Penthester atricapillus atricapillus*) | 17 |
| Childs, Thomas W. | 117 |
| Chimney Swift (*Chaetura pelagica*) | 64 |
| *Clematis paniculata* | 109 |
| *Clematis viticella* | 6 |
| *Clerodendron trichotomum* | 51 |
| *Clethra alnifolia* | 109 |
| *Coccyzus americanus americanus* (Yellow-billed Cuckoo) | 64 |
| *Colaptes auratus luteus* (Northern Flicker) | 33 |
| Compton | 3 |
| Conifers | 27–30 |
| Conifers, Western | 39 |
| Conservation Department of New York | 39 |
| Conservation of Trees | 30 |
| *Cornus mas* | 106 |
| Cornus species | 6 |
| Corrections | 67, 100 |
| *Corthyliocalendula calendula* (Eastern Ruby-crowned Kinglet) | 17 |
| *Corvus brachyrhynchos brachyrhynchos* (Eastern Crow) | 17 |
| *Corylopsis* | 107 |
| Cowbird, Eastern (*Molothrus ater ater*) | 66 |
| Crab, Bechtel's | 105 |
| Crab, Carmine | 105 |
| Crab, Parkman | 105 |
| Crab, Prairie | 103, 105 |
| Crab, Red-vein | 105 |
| Crab, Scheidecker's | 104 |
| Crab, Tea | 105 |
| Creeper, Brown (*Certhia familiaris americana*) | 17 |
| Crocker, Dr. William | 8 |
| *Cryptomeria japonica* | 35 |
| *Cryptomeria japonica*, D. Don. | 28 |
| *Cryptomeria japonica*, Lobbii, Carr. | 28 |
| Cuckoo, Yellow-billed (*coccyzus americanus americanus*) | 64 |
| *Cunninghamia lanceolata*, Hook. | 28 |
| *Cyanocitta cristata cristata* (Northern Blue Jay) | 17 |
| Coral berries | 6 |
| Cypress (*Chamaecyparis*) | 10 |
| *Cytisus* | 107 |
| *Davidia involucrata*, Baill. | 51 |
| Deciduous trees | 39, 40 |
| *Dendrobium* | 120 |
| *Dendroica aestiva aestiva* (Eastern Yellow Warbler) | 65 |
| *Dendroica castanea* (Bay-breasted Warbler) | 65 |
| *Dendroica coronata* (Myrtle Warbler) | 65 |
| *Dendroica fusca* (Blackburnian Warbler) | 65 |
| *Dendroica palmarum hypochrysea* (Yellow Palm Warbler) | 65 |
| *Dendroica pennsylvanica* (Chestnut-sided Warbler) | 65 |
| *Dendroica striata* (Black-poll Warbler) | 65 |
| Deutzias | 108 |
| *Deutzia carnea stellata*, Rehd. | 51 |
| *Deutzia crenata*, D., *scabra* and varieties | 52 |
| *Deutzia discolor*, Hemsl. | 51 |
| *Deutzia gracilis*, Sieb. & Zucc. | 52 |
| *Deutzia longifolia*, Frane | 51 |
| *Deutzia parviflora*, Bge. | 51 |
| *Deutzia rosea*, Rehd. | 52 |
| *Deutzia* species | |
| *Deutzia Vilmorinae*, Lemoine | 51 |
| *Diervilla florida*, Sieb. & Zucc. | 52 |
| Diseases, Plane Tree | 8, 22 |
| Distribution of Seeds and Plants | 5 |
| Dixon, Mrs. Eleanor Widener | 120 |
| Doak, Dr. K. D. | 45–49 |
| *Dolichonyx oryzivorus* (Bobolink) | 66 |
| Dove Tree | 51 |
| Dreer, Henry A., Inc. | 56 |
| *Dryobates pubescens medianus* (Northern Downy Woodpecker) | 17 |
| *Dryobates villosus villosus* (Eastern Hairy Woodpecker) | 17 |
| Duck, Common Mallard (*Anasplatyrhynchos platyrhynchos*) | 16 |
| *Dumetella carolinensis* (Catbird) | 64 |
| Dutch Elm Disease | 6, 8, 19–21 |
| *Elaeagnus multiflora* Thunbergii | 52 |
| *Elaeagnus pungens maculata*, Rehd. | 52 |
| Elm, Small-leaved Chinese | 6 |
| *Epidendrum* | 120 |
| *Epiphytes* | 38 |
| *Erica carnea* | 106 |
| *Erica vagans*, L. | 52 |
| Erosion | 82, 83 |
| *Evodea Daniellii* | 6 |

| | Page |
|---|---|
| Fairmount Park Commission | 40 |
| *Falco sparverius sparverius* (Eastern Sparrow Hawk) | 16 |
| Fearon, Charles | 120 |
| Finch, Eastern Purple (*Capodacus purpureus purpureus*) | 33 |
| Flicker, Northern (*Colaptes auratus luteus*) | 33 |
| Florida Moss | 38 |
| Flowering Crab-apples | 103 |
| Flycatcher, Northern Crested (*Myiarchus crinitus boreus*) | 64 |
| Fogg, Dr. John M., Jr. | 98–100 |
| *Fontanesia Fortunei*, Carr. | 52 |
| Forests and Waters, Department of | 120 |
| Foreword | 2 |
| *Forsythia* | 107 |
| *Forsythia intermedia*, Zabel. | 52 |
| *Forsythia suspensa Fortunei*, Rehd. | 52 |
| *Forsythia suspensa*, Vahl. | 52 |
| *Forsythia viridissima*, Lindl. | 52 |
| Fosberg, F. R. | 118 |
| *Fothergilla* | 108 |
| Garden News | 56 |
| *Genista* | 107 |
| *Geothypis trichas trichas* (Maryland Yellow Throat) | 65 |
| Glendinning, Colonel Robert | 55 |
| Goldfinch, Eastern (*Spinus tristis tristis*) | 18 |
| *Gordinia alatamaha* | 109 |
| Grackle, Purple (*Quiscalus quiscula quiscula*) | 33 |
| Grosbeak, Rose-breasted (Hedymeles ludovicianus) | 68 |
| Growth-Promoting Action of Ethylene and of Other Chemical Substances | 77–81 |
| *Hamamelis japonica* | 106 |
| *Hamamelis mollis* | 106 |
| *Hamamelis vernalis* | 106 |
| *Hamamelis virginiana* | 106 |
| Harper, William Warner | 67 |
| Hawk, Cooper's (*Accipiter Cooperi*) | 16 |
| Hawk, Eastern Red-tailed (*Bueto borealis borealis*) | 16 |
| Hawk, Eastern Sparrow (*Falco sparverius sparverius*) | 16 |
| Hawk, Northern Red-shouldered (*Buteo lineatus lineatus*) | 16 |
| Hawk, Sharp-shinned (*Accipiter velox velox*) | 33 |
| Heather, Cornish | 52 |
| *Hedymeles ludovicianus* (Rose-breasted Grosbeak) | 66 |
| Hemlocks | 24 |
| Hemlocks, common | 6 |
| Herbarium of the Morris Arboretum (The) | 98–100 |
| Heron, Eastern Green (*Butoides virescens virescens*) | 16 |
| Heron, Great Blue | 33 |
| *Hirundo erythrogaster* (Barn Swallow) | 64 |
| Holly, English | 53 |
| *Hovenia dulcis*, Thunb. | 52 |
| Hummingbird, Ruby-throated (*Archilochus colubris*) | 64 |
| Hunnewell Estate | 39 |
| Hydrangea "Pee Gee" | 109 |
| *Hylocichla fuscens fuscens* (Veery) | 65 |
| *Hylocichla mustelina* (Wood Thrush) | 64 |
| *Hypericum* species | 6 |
| *Icterus galbula* (Baltimore Oriole) | 66 |
| *Idesia polycarpa*, Maxim. | 52 |
| *Ilex crenata*, Thunb. | 53 |
| *Ilex crenata*, var. | 52 |
| *Ilex aquifolium*, L. | 53 |
| *Ilex Pernyi*, Franch. | 53 |
| Illuminating Gas Injury | 8, 38, 59–62 |
| Indigo Bunting (*Passerina cyanea*) | 66 |
| Iris | 39 |
| Ivy, English | 39 |
| Jackson, Dr. L. W. R. | 8 |
| Jenkins, Charles F. | 24 |
| Jones, Dr. Frank Morton | 37 |
| Jump, John Austin | 97, 98 |
| *Junco hyemalis* (Slate-colored Junco) | 18 |
| Junco, Slate-colored (*Junco hyemalis*) | 18 |
| Juniper | 27 |
| *Juniperus chinensis*, L. | 76 |
| *Juniperus chinensis Pfitzeriana*, Spaeth | 76 |
| *Juniperus communis*, L. | 76 |
| *Juniperus excelsa stricta* | 42 |
| *Juniperus virginiana* | 42 |
| *Juniperus virginiana*, L. | 76 |
| *Kalmia latifolia* | 6 |
| Kildeer (*Oxyechus vociferus vociferus*) | 33 |
| Kingfisher, Eastern Belted (*Megaceryle alcyon alcyon*) | 16 |
| Kinglet, Eastern Golden-crowned (*Regulus satrapa satrapa*) | 33 |
| Kinglet, Eastern Ruby-crowned (*Corthylio calendula calendula*) | 17 |
| *Koelreuteria paniculata* | 26 |
| *Kolkwitzia amabilis*, L. | 6 |
| Koster Nursery Co. | 24 |

Page

Labels ..... 5
Laburnum ..... 108
*Laelia* ..... 120
Lambert, James ..... 11, 27–30, 50–55, 74–76
Larch, European ..... 26
*Larix decidua* ..... 26
Larsen, Esther L. ..... 118
Lecture Course ..... 5
*Libocedrus decurrens*, Torr. ..... 29
*Ligustrum acuminatum*, Koehne. ..... 53
*Ligustrum amurense*, Carr. ..... 53
*Ligustrum ovalifolium*, Hassk. ..... 53
*Ligustrum* species ..... 6
Lilac scions ..... 40
Lilacs ..... 71–73
*Liriodendron tulipifera* ..... 47, 49
*Lonicera* ..... 6
*Lonicera fragrantissima* ..... 106
*Lonicera sempervirens* ..... 109
Magnolia ..... 90
*Magnolia acuminata* ..... 92
*Magnolia* anise ..... 91
*Magnolia denudata* ..... 107, 91
*Magnolia Fraseri* ..... 92
*Magnolia grandiflora* ..... 53, 93
*Magnolia Kobus* ..... 90, 91, 107
*Magnolia liliflora* ..... 90, 91
*Magnolia macrophylla* ..... 92
*Magnolia obovata* ..... 92
*Magnolia parviflora* ..... 92
*Magnolia rosea* ..... 91
*Magnolia salicifolia* ..... 91
*Magnolia Soulangeana* ..... 91, 107
*Magnolia Soulangeana*, Andre Le Roy ..... 91
*Magnolia Soulangeana Brozzoni* ..... 91
*Magnolia Soulangeana Lennei* ..... 91, 108
*Magnolia Soulangeana Norbertiana* ..... 91
*Magnolia Soulangeana speciosa* ..... 91
*Magnolia Soulangeana Verbanica* ..... 91
*Magnolia stellata* ..... 90, 107
*Magnolia tripetala* ..... 26, 90, 92
*Magnolia virginiana* ..... 92
*Magnolia Watsonii* ..... 92
*Magnolia Wilsonii* ..... 92
*Mahonia Aquifolium* ..... 89, 93, 107
*Mahonia Aquifolium*, Nutt. ..... 95
*Mahonia Bealii* ..... 93, 95

Page

*Mahonia Fremontii*, Fedde. ..... 95
*Mahonia japonica* ..... 53
*Mahonia nervosa*, Nutt. ..... 95
*Mahonia repens* ..... 89
*Mahonia repens*, G. Don. ..... 95
*Malacosoma americana* ..... 45
*Malus arnoldiana* ..... 105, 108
*Malus atrosanguinea* ..... 105, 108
*Malus baccata* ..... 108
*Malus baccata mandshurica* ..... 104
*Malus bracteata* ..... 105
*Malus coronaria* ..... 103, 105
*Malus floribunda* ..... 104, 108
*Malus Halliana Parkmanii* ..... 105, 108
*Malus hupehensis* ..... 105
*Malus ioensis* ..... 103, 105
*Malus micromalus* ..... 108
*Malus niedzwetzkyana* ..... 105
*Malus prunifolia* ..... 104
*Malus purpurea* ..... 105, 108
*Malus Sargentii* ..... 104, 105, 108
*Malus Scheideckeri* ..... 104, 108
*Malus Sieboldii* ..... 104, 105
*Malus spectabilis, Riversii* ..... 105
*Malus toringoides* ..... 105
*Malus zumi* ..... 105
Masonic Home, Elizabethtown ..... 40, 119
May, Dr. Curtis ..... 8, 19
May Day Frolic ..... 5
McQuilkin, William E. ..... 118
Meadowlark, Eastern (*Sternella magna magna*) ... 33
*Megaceryle alcyon alcyon* (Eastern Belted Kingfisher) ..... 16
*Melospiza georgiana* (Swamp Sparrow) ..... 66
*Melospiza melodia melodia* (Eastern Song Sparrow) 18
*Miltonia* ..... 120
*Mniotilta varia* (Black and White Warbler) ..... 65
*Molothrus ater ater* (Eastern Cowbird) ..... 66
Monograph ..... 1, 19
Montgomery, Colonel Robert H. ..... 7
Morris, John T. ..... 3
Morris, Lydia T. ..... 3
Morris Arboretum Fellows ..... 117, 118
Mourning Dove (*Zenaidura macroura carolinensis*) 16
*Myiarcgus crinitus boreus* (Northern Crested Fly-Catcher) ..... 64
Mycorrhizae of Trees and Shrubs ..... 45–49

| | Page |
|---|---|
| Nalle, Albert | 119 |
| *Nandina domestica*, Thunb. | 54 |
| National Museum | 56 |
| New York Botanic Garden | 24, 40, 56, 120 |
| *Nicotiana tabacum* | 80 |
| Nuthatch, Red-breasted (*Sitta canadensis*) | 17 |
| Order of Bloom of Woody Trees and Shrubs (The) | 106 |
| Oriole, Baltimore (*Icterus galbula*) | 66 |
| Osprey (*Pandion haliaetus carolinensis*) | 64 |
| Outdoor Arts Company | 39 |
| Oven-bird (*Seiurus aurocapillus*) | 65 |
| Oxford Paper Co. | 39 |
| *Oxydendron arboreum*, D. C. | 6, 26 |
| *Oxyechus vociferus vociferus* (Killdeer) | 33 |
| *Pandion haliaetus carolinensis* (Osprey) | 64 |
| *Passer domesticus domesticus* (English Sparrow) | 18 |
| *Passerina cyanea* (Indigo Bunting) | 66 |
| *Passerella iliaca iliaca* (Eastern Fox Sparrow) | 18 |
| Pennsylvania State College | 39 |
| *Penthrestes atricapillus atricapillus* (Black-capped Chicadee) | 17 |
| Peony Plants | 39 |
| *Phasianus colchicus torquatus* (Ring-necked Pheasant) | 16 |
| Pheasant, Ring-necked (*Phasianus colchicus torquatus*) | 16 |
| *Philadelphus* species | 6 |
| Phoebe, Eastern (*Sayornis phoebe*) | 64 |
| *Picea Abies*, dwarf variety | 75 |
| *Picea Abies*, Karst | 75 |
| *Picea Abies* pendula, Nash | 75 |
| *Picea Engelmanni*, Engelm. | 75 |
| *Picea glauca Albertiana*, Sarg. | 75 |
| *Picea glauca nana*, Rehd. | 95 |
| *Picea Koyamai*, Shiras | 75 |
| *Picea omorika*, Purkyne | 75 |
| *Picea polita*, Carr | 75 |
| *Picea pungens glauca*, Beiss. | 75 |
| *Picea Smithiana*, Boiss. | 75 |
| *Pieris floribunda* | 107 |
| *Pieris japonica* | 107 |
| Pine, Austrian | 35 |
| Pine, Himalayan | 10 |
| Pine, Himalayan Disease | 8 |
| Pine, Japanese Black | 26 |
| Pine, Long Leaf | 27 |
| Pine, Nut | 58 |
| Pine, One-leaved | 57, 58 |
| Pine, Swiss Stone | 10 |
| Pine, White | 30, 49, 69, 70 |
| Pinetum | 9 |
| *Pinus Banksiana*, Zucc. | 76 |
| *Pinus Cembra*, L. | 10, 35, 42, 101, 102 |
| *Pinus cembroides*, Zucc., var. *monophylla*, Voss | 57, 58 |
| *Pinus columnaris*, Beissn. | 102 |
| *Pinus densiflora umbraculifera*, Mayr. | 76 |
| *Pinus excelsa*, Wall. | 10, 34, 35, 40, 85 |
| *Pinus monophylla* | 35 |
| *Pinus palustris* | 27 |
| *Pinus resinosa* | 39 |
| *Pinus strobus* | 39, 49 |
| *Pinus sylvestris*, L. | 76 |
| *Pinus taeda*, L. | 76 |
| *Pinus Thungergiana* | 26 |
| *Pinus zebrina*, Bailey | 86, 97 |
| *Pipilo erythrophthalmus erythrophthalmus* (Red-eyed Towhee) | 66 |
| *Piranga erythromelas* (Scarlet Tanager) | 66 |
| Pitcher Plants, North American | 37 |
| *Planera aquatica* | 39 |
| Plant Collecting Trip | 68 |
| Plant Hybridization, Beginnings of | 19 |
| *Platanus* species | 22 |
| *Platycerium grande* | 7 |
| *Polygonum Aubertii* | 109 |
| *Poncirus trifoliata*, Raf. | 54 |
| *Popillia japonica* | 109 |
| Poplar species | 6 |
| Poplar, Yellow | 47, 49 |
| Poplars, Paper | 39 |
| *Populus tremuloides* | 106 |
| *Prinsepia sinensis* | 107 |
| Privets | 6 |
| Protoplasm | 37 |
| *Prunus Sargentii* | 107 |
| *Prunus subhirtella* | 107 |
| *Prunus subhirtella pendula* | 107 |
| *Prunus subhirtella pendula Tanaka* | 54 |
| *Prunus yedoensis* | 107 |
| *Pyracantha coccinea Lalandii*, Dipp. | 54 |
| Raisin Tree, Japanese | 52 |
| Recent Gifts | 119, 120 |
| Redstart, American (*Setophaga ruticilla*) | 66 |

Page

*Regulus satrapa satrapa* (Eastern Golden-Crowned Kinglet) ..... 33
*Rhododendron arborescens* ..... 109
*Rhododendron*, "Boule de Neige" ..... 108
*Rhododendron calendulaceum* ..... 108
*Rhododendron* Hybrids ..... 40
*Rhododendron maximum* ..... 109
*Rhododendron mucronulatum* ..... 106
*Rhododendron obtusum* ..... 107
*Rhododendron obtusum amoenum*, Rehd. ..... 54
*Rhododendron obtusum Kaempferi* ..... 108
*Rhododendron obtusum* var. *Hinodegiri* ..... 54
*Rhododendron Schlippenbachii* ..... 108
*Rhododendron Vaseyi* ..... 108
*Rhododendron yedoense poukhanense* ..... 108
*Ribes odoratum* ..... 107
*Richmondena cardinalis cardinalis* (Eastern Cardinal) ..... 18
Robin, Eastern (*Turdus migratorius migratorius*) 33
Rock, Dr. Joseph F. ..... 5
*Rosa blanda* ..... 108
*Rosa hugonis* ..... 108
*Rosa multiflora* ..... 108
*Rosa primula* ..... 108
*Rosa setigera* ..... 109
*Rosa virginiana* ..... 108
Rosenbluth, E. M. ..... 39
Roses ..... 56
Rotan, Mrs. Samuel P. ..... 39
*Salix babylonica*, L. ..... 10
*Salix discolor* ..... 106
Sandpiper, Spotted (*Actitis macularia*) ..... 64
Saul, Maurice Bower ..... 39, 40, 120
*Sayornis phoebe* (Eastern phoebe) ..... 64
*Scleroderma vulgare* ..... 47
*Scolytus* ..... 20
Seed Distribution ..... 6
Seifriz, Dr. William ..... 37
*Seirus aurocapillus* (Oven-bird) ..... 65
*Seirus noveboracensis noveboracensis* (Northern Water Thrush) ..... 65
Sequoia ..... 39
*Sequoia gigantea*, Decne. ..... 29
*Setophaga ruticilla* (American Redstart) ..... 66
Sinkler, Wharton ..... 7, 38
*Sitta canadensis* (Red-breasted Nuthatch) ..... 17
*Sitta caroliensis caroliensis* (White-breasted Nuthatch) ..... 17

Page

Slavin, Arthur D. ..... 90–93
Smith, Lewis MacCuen ..... 15–18, 32–33, 63–66
Snowberries ..... 6
Sorrel Tree ..... 6
Sparrow, Eastern Chipping (*Spizella passerina passerina*) ..... 66
Sparrow, Eastern English (*Passer domesticus domesticus*) ..... 18
Sparrow, Eastern Field (*Spizella pusilla pusilla*) .. 66
Sparrow, Eastern Fox (*Passerella iliaca iliaca*) ... 18
Sparrow, Eastern Savannah (*Passerculus sandwichensis savanna*) ..... 66
Sparrow, Eastern Song (*Melospiza melodia melodia*) ..... 18
Sparrow, Swamp (*Melospiza georgiana*) ..... 66
Sparrow, Eastern Tree (*Spizella arborea arborea*) 66
Sparrow, White-throated (*Zenotrichia albicollis*) .. 18
*Sphaeropsis malorum* ..... 35, 97, 98
*Sphyrapicus varius varius* (Yellow-bellied Sapsucker) ..... 17
*Spinus tristis tristis* (Eastern Goldfinch) ..... 18
*Spiraea Thunbergi* ..... 107
*Spizella arborea arborea* (Eastern Tree Sparrow) . 66
*Spizella passerina passerina* (Eastern Chipping Sparrow) ..... 66
*Spizella pusilla pusilla* (Eastern Field Sparrow) ... 33
Staghorn Fern ..... 7
*Staphylea pinnata*, L. ..... 54
Starling (*Sturnus vulgaris vulgaris*) ..... 17
Stout, Mrs. Charles H. ..... 40
*Sturnella magna magna* (Eastern Meadowlark) ... 33
*Sturnus vulgaris vulgaris* (Starling) ..... 17
*Styrax japonica*, Sieb. & Zucc. ..... 55
*Styrax obassia*, Sieb. & Zucc. ..... 55
Swallow, Barn (*Hirundo erythrogaster*) ..... 64
Swan Pond ..... 25
Swarthmore Arboretum ..... 40, 120
Swartley, John C. ..... 24, 93–96
*Symphoricarpus* species ..... 6
*Syringa* ..... 71–73
*Syringa hyacinthiflora* ..... 108
*Syringa Josikaea* Jacq. ..... 71
*Syringa oblata* ..... 108
*Syringa persica*, L. ..... 71
*Syringa pubescens*, Turcz. ..... 71
*Syringa villosa*, Vahl. ..... 71
*Syringa vulgaris*, L. ..... 71
Tanager, Scarlet (*Piranga erythromelas*) ..... 66

Page

*Taxus baccata fastigiata*, Loud. ..... 30
*Taxus canadensis aurea*, Hart. ..... 30
*Taxus cuspidata nana*, Rehd. ..... 76
*Taxus cuspidata*, Sieb. & Zucc. ..... 76
Taxus plants .....24, 27–30, 39
Tent Caterpillar (The) .....43–45
*Terrestrial Pineapple* ..... 38
Teuscher, Henry .....8, 35, 36
Thrasher, Brown (*Toxostoma rufum*) ..... 64
Thrush, Northern Water (*Seirus noveboracensis noveboracensis*) ..... 65
Thrush, Wood (*Hylocichla mustelina*) ..... 64
*Thuja occidentalis* ..... 6
*Thuja occidentalis Boothii* ..... 76
*Thuja occidentalis globosa*, Gord. ..... 76
*Thuja occidentalis Rosenthalii*, Ohlen ..... 76
*Thuja occidentalis Vervaenaena*, Gord. ..... 76
*Thuja orientalis*, L. ..... 76
*Thuja oridentalis*, Rosedale hybrid forms..... 76
*Tiphia* ..... 115
*Tiphia popilliavora* ..... 115
Titmouse, Tufted (*Baeolophus bicolor*) ..... 17
Towhee, Red-eyed (*Pipilo erythrophthalmus erythrophthalmus*) ..... 66
Towson Nurseries .....40, 120
*Toxostoma rufum* (Brown Thrasher) ..... 64
*Tripterygium Regelii* ..... 109
*Troglodytes aedon aedon* (Eastern House Wren)
True, Dr. Rodney H. .....30, 31, 82, 83
*Tsuga Brunoniana*, Carr. ..... 76
*Tsuga canadensis* ..... 6
*Tsuga canadensis*, Carr. ..... 76
*Tsuga caroliniana*, Engelm. ..... 76
*Tsuga diversifolia*, Mast. ..... 76
*Tsuga dumosa*, Sarg. ..... 76
*Tsuga Sieboldii*, Carr. ..... 76
*Turdus migratorius migratorius* (Eastern Robin). 33
Turkey Vulture (*Cathartes aura septentrionalis*).. 63
*Ulmus parvifolia*, Jacq. ..... 6
Umbrella Tree ..... 26
U. S. Department of Agriculture..... 40
Varnish Tree, Japanese ..... 26
Veery (*Hylocichla fuscens fuscens*) ..... 65
*Vermivora pinus* (Blue-winged Warbler) ..... 65
*Vermivora ruficapilla ruficapilla* (Nashville Warbler) ..... 65

Page

*Viburnum betulifolium*, Batel. ..... 55
*Viburnum hupehense*, Rehd. ..... 55
*Viburnum opulus nana* ..... 55
*Viburnum rhytidophyllum*, Hemsl. ..... 55
*Viburnum scabrellum*, Chapm. ..... 55
*Viburnum tomentosum plicatum* ..... 108
*Viburnum tomentosum* sterile, K. Koch..... 55
View at the Swan Pond ..... 25
View in Japanese Garden ..... 41
Vireo, Red-eyed (*Vireo divaceus*) ..... 65
*Vitex* ..... 109
Walcott, Mary Vaux ..... 37
Warbler, Bay-breasted (*Dendroica castanea*)..... 65
Warbler, Black and White (*Mniotilta varia*)..... 65
Warbler, Blackburnian (*Dendroica fusca*) ..... 65
Warbler, Black-poll (*Dendroica striata*) ..... 65
Warbler, Blue-winged (*Vermivora pinus*) ..... 65
Warbler, Chestnut-sided (*Dendroica pennsylvanica*) 65
Warbler, Eastern Yellow (*Dendroica aestiva aestiva*) ..... 65
Warbler, Myrtle (*Dendroica coronata*) ..... 65
Warbler, Nashville (*Vermivora ruficapilla ruficapilla*) ..... 65
Warbler, Yellow Palm (*Dendroica palmarum hypochrysea*) ..... 65
Waxwing, Cedar (*Bombycilla cedrorum*) ..... 17
Weigelas ..... 108
Wherry, Dr. Edgar T. ..... 4, 37
Willow, Weeping ..... 10
Winter Injury and Hardiness .....8, 35, 36
Winter Injury to Conifers at the Morris Arboretum .....27–30
Winter Injury to Miscellaneous Trees and Shrubs. 50–55
Winter Lecture Course .....68, 84
Wister, John C. .....40, 68, 71–73, 119
Woodpecker, Eastern Hairy (*Dryobates villosus villosus*) ..... 17
Wren, Eastern House (*Troglodytes aedon aedon*).. 64
Yellow Throat, Maryland (*Geothlypis trichas trichas*) ..... 65
Yew, Plum ..... 42
York, Dr. Harlan H. .....8, 34, 35
*Zenaidura macroura carolinensis* (Eastern Mourning Dove) ..... 16
Zirkle, Dr. Conway ..... 19
*Zonotrichia albicollis* (White-throated Sparrow).. 18